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The case for interoperability in global research

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Introduction

This Discussion Paper, focussing on defining *interoperability* in a global research sense, is the first of two that will capture the main threads of discussion from a recent symposium hosted jointly by FEAST and The University of Queensland (UQ) on *Enhancing interoperability in the emerging global research order*.

Full details of the symposium, including speaker biographies and presentations, further references, and other resources are available on the FEAST website at *www.feast.org/symposium2011*.

Background & motivation

FEAST's ten years of experience in helping Australian researchers engage with the European Union's Framework Programmes (FP)[6] has highlighted the challenges that researchers face in linking domestically funded research into larger international projects.[7] These challenges are not confined to the Australian context, and are the consequence of endeavouring to mesh heterogeneous national research funding systems for increasingly international research activities.

Over the past two decades the increase in global research output has been driven largely by an increase in international research collaborations (highlighted by the need to solve major global problems, for example in medicine and the environment). It is evidenced in increasing rates of co-publication, co-patenting and mobility of labour between countries and fields of research. Such international efforts are generally of a larger scale, and exhibit increased quality and impact, than purely domestic research.[8] Matters of national significance are relying more and more on globally conducted research to provide solutions, since international cooperation enables the pooling of resources, reduces risks, allows for knowledge sourcing, aids in globalization efforts, and many other tangible and intangible benefits.[9]

The increasing connectedness of events globally, and the rapidity of transmission of their manifestations and consequences (e.g. the Asian and, more recently, Global Financial Crisis, diseases such as SARS and Swine Flu, Internet crime etc.), demands that if research is to be a part of the solution (i.e. understanding as a basis for preparedness, prevention/mitigation and response) then the international links need to be capable of rapid and flexible configuration and re-configuration.

FEAST's reflection on the global strategic aspects of these challenges prompted an exploratory paper[10] looking at the implications of these challenges for national research and innovation policies as well as international science diplomacy. The paper provided the underpinning idea for a symposium that was jointly hosted by FEAST and The University of Queensland (UQ), in Brisbane on 24-25 March 2011, titled *Enhancing interoperability in the emerging global research order*.

The symposium's objectives were to:

1. Refine and develop the notion of *interoperability* as a new strategic objective in facilitating international cooperation in science and technology;
2. Consider the implications of the geopolitical dimension to international cooperation in science and technology for delivering enhanced *interoperability*;
3. Develop and propose improved policy stances able to balance the inherently international role of public science against the national competition-driven emphasis on innovation;
4. Explore new forms of agile contractual templates able to facilitate *interoperability*, and;
5. In the light of the above, agree a joint stakeholder statement and cooperative action plan for refining and demonstrating the interoperability-based approach in a politically sensitive geopolitical context.[11]

[6] *cordis.europa.eu/fp7*

[7] FEAST Discussion Paper 3/10

[8] FEAST Discussion Paper 1/09

[9] Greater detail about these issues can be found in the Royal Society policy document *Knowledge, Networks and Nations: Global scientific collaboration in the 21st century*

[10] Enhancing interoperability in the emerging global research order, in *FEAST - Forum for European-Australian Science and Technology cooperation*

[11] This objective has now been captured via a communiqué, available from *www.feast.org/symposium2011/FEAST-UQ_Symposium_2011_communique.pdf*

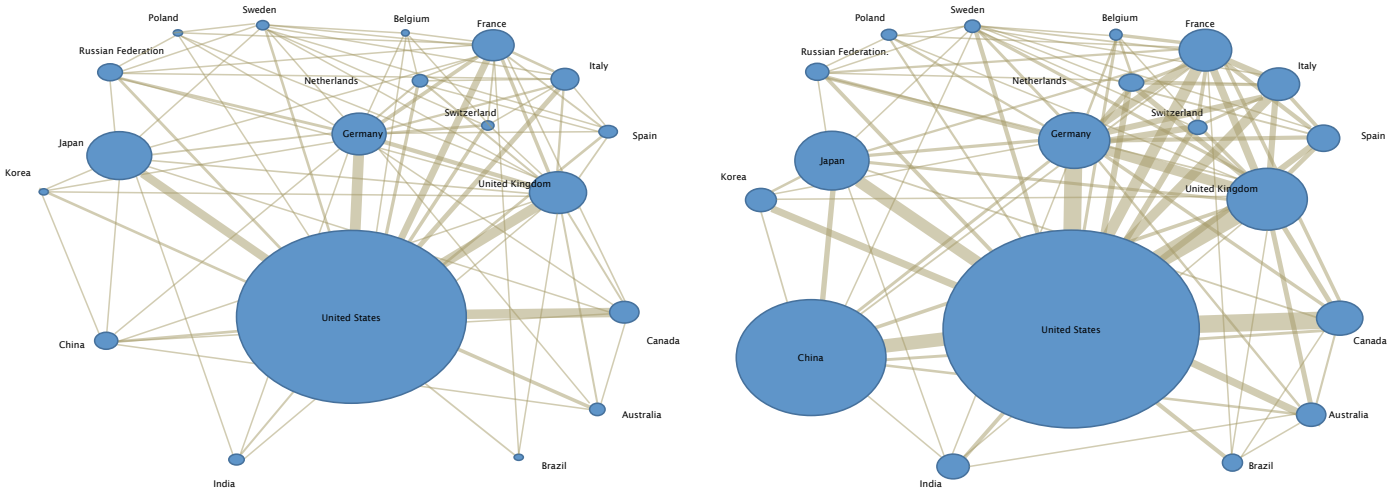

Figure 1: Scientific publications and co-authored articles 1998 (left) and 2008 (right). *OECD Science, Technology and Industry Outlook 2010*.

The symposium was designed for people who formulate policy and decide on the architectures of funding programs and international agreements relating to global research. It provided a forum where they could exchange experience and thinking for mutual benefit, with the aim of facilitating full conversation between all participants.

The 40 attendees were from a variety of organisations concerned with these matters: Australian funding agencies, Australian and New Zealand government departments, senior research managers from Australian universities, international sections of national research organisations, science liaison areas of embassies in Australia, the Learned Academies, the national coordinating bodies of research and innovation centres and of Australia's major research universities, and other standardizing and coordinating bodies such as international scientific unions and government agencies. Discussion was stimulated by a lively group of international and Australian based speakers, expert in the policy dimensions of research and innovation at national levels and in the international context.

Strong shared interests kept those present engaged in discussion with each other throughout the two days. Their feedback has confirmed the value of the symposium and the richness of the deliberations.

Interoperability in a research context

Interoperability as a general term means the ability of systems to work together, whatever those systems might be. It implies cooperation rather than integration, with the flexibility to come together and to disengage as needed. A working definition of interoperability in the research domain has been set out in the background paper *Enhancing interoperability in the emerging global research order*:

> Interoperability in an international S&T context refers to the development of the capacity to configure cooperative research activity quickly and cost-effectively in such a way that it exploits complementary capabilities.[12]

Unpacking this definition requires both setting out the global research context and exploring what interoperability means in that context. This is the focus of this paper. We go on to look at the challenges and possible solutions to enhancing interoperability for policy and practice in our next Discussion Paper.

The context to which this notion of interoperability is being applied is the increasingly global research endeavour. The past two decades has seen substantial growth in international research collaborations, and the significance of that growth in many key directions. The geopolitics of the research environment has also been changing significantly, with the emergence of the new powerful centres of knowledge production outside of Europe, North America and Japan – the regions that so dominated 20th century science and technology advancement. These new centres are not displacing the older centres but rather adding to the total research

[12] Enhancing interoperability in the emerging global research order, in *FEAST – Forum for European-Australian Science and Technology cooperation*

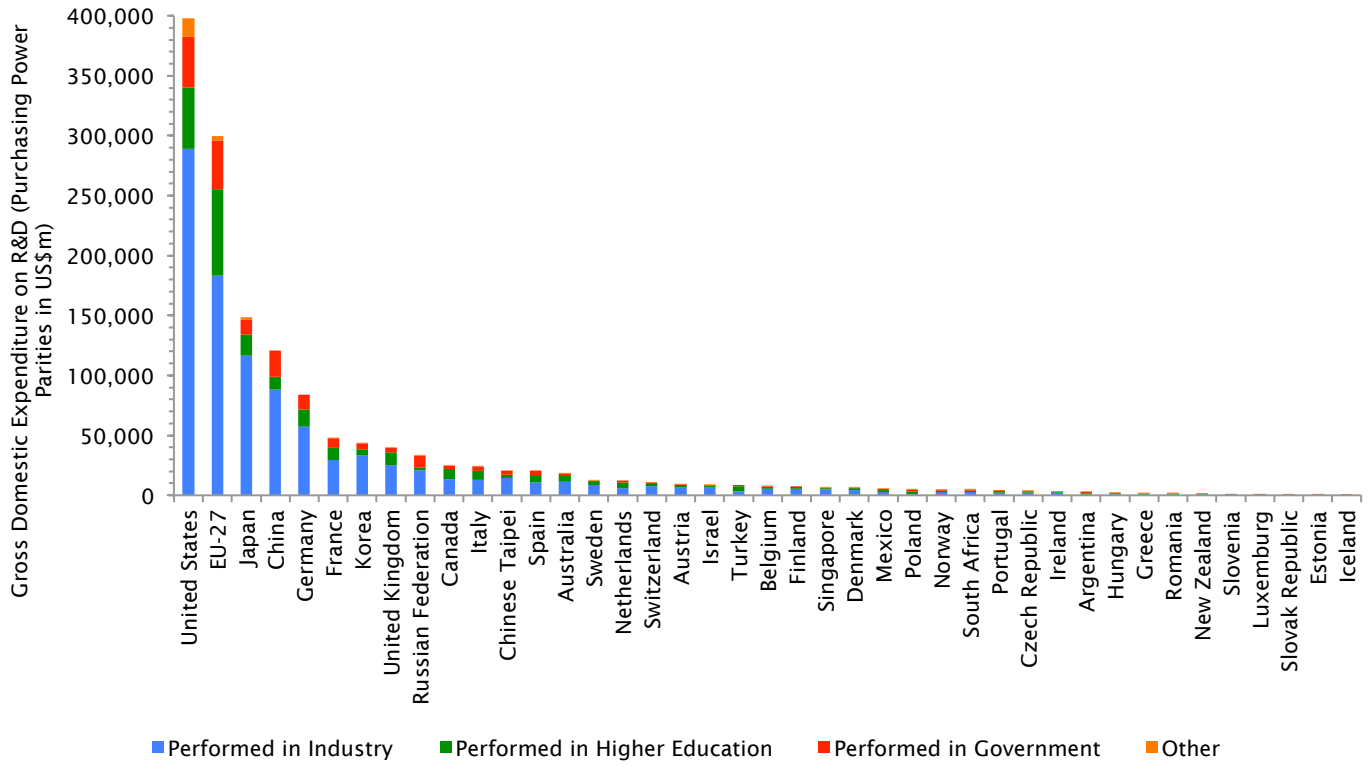

Figure 2: Domestic R&D Expenditures. ***OECD Main Science and Technology Indicators, Vol. 2010/2.***

enterprise, and adding to the web of collaborations across the globe. For instance, the number of researchers worldwide increased from 5.7 million in 2002 to 7.1 million in 2007.[13]

Figure 1, comparing the years 1998 and 2008, shows the increasing amount and density of international collaboration as indicated through scientific publications, and the emergence of the new loci of research activity.

Roles and constraints of international collaboration

In this increasingly interconnected research environment there is an inverse relationship between the size of a national system (the disparity of which is clearly shown in Figure 2) and the importance for it to be internationally engaged. For example, in the case of Australia, which only generates approximately 3% of the new knowledge each year, it must collaborate internationally in order to gain full access to the vast bulk of knowledge that is generated outside of the country. The USA, on the other hand, has comparatively lower levels of international collaboration because its large domestic system enables greater internal collaborations, hence the incentive for external collaboration is less compelling.

During the development of new knowledge, those who are involved in its development have advance, and often privileged, access to the findings. To understand emerging trends and issues, and where risks and opportunities lie, a country needs to be engaged in the production of that new knowledge via global partnerships. For example, nations that are involved in international research and innovation efforts in the development of clean energy technologies will more quickly be able to adopt and commercialise those technologies.

The potential for research and innovation cooperation to tackle internationally acknowledged problems and to contribute to global as well as national development has vastly increased. While governments and the public widely acknowledge the need for multilateral cooperation to tackle such problems, the policy and funding pressures on governments are increasing in scale as a result of such developments as the global financial crisis, and climate change. So, governments are typically pulled between increasing research collaborations to address important world-wide problems and to decreasing such collaboration in an attempt to limit the escape of national

[13] *UNESCO Science Report 2010*

science and technology (S&T) knowledge to competitor countries.

Additionally, national research and innovation systems and research funding models were developed at different times and to fulfil different national objectives, almost entirely directed towards internal scientific and societal needs, and often with explicit goals related to increased industrial competitiveness vis-à-vis other nations. These might include:

- National S&T systems developed independently for the most part, and reflect different national pathways of economic, social, and military development (or different histories);
- Differences in national political and administrative cultures;
- Different national understandings of the proper roles of governments;
- Different presumptions about the role of the state in guiding or stimulating development.

Hence, it is no simple task to configure them to work together.

Existing global interoperable systems

Examples exist throughout modern history, where nations perceive mutual interest opportunities, of the creation of interoperable systems. For example, in telecommunications, air traffic control, space exploration and exploitation, timekeeping, fundamental measurements, navigation and geomatics, and infectious disease controls among others – all are areas where interoperable systems have been or are being established for the governance of globally significant technical matters.

The establishment of these regimes in specific areas has been successful where:

- It is essential to the success of a national mission;
- Some national sovereignty is sacrificed for the achievement of national objectives;
- Issues are addressed via binding formal agreements, typically by treaty;
- International permanent secretariats are established;
- Nations' diplomatic/foreign policy agencies have the formal lead;
- Non-diplomatic agencies, particularly national research agencies, play key roles.

These examples offer key lessons for the level of government commitment and engagement required to improve interoperability.

Implications for RDI arrangements

How useful are these models of global cooperation when looking at interoperability in the research context? Are research system interoperability issues amenable to solutions at the science diplomacy level?[14]

In the area of mega-science, where the requirements and costs of infrastructure are too great for any individual nation to undertake alone, or the scope of the research is far beyond the capacity of researchers in a single country to manage, the requirements for success are the same. These include diplomatic and legal frameworks, involvement of specialist scientific organisations from member nations, and commitments from national governments (particularly funding). Examples of such initiatives, that Australia has been actively involved with, include:

- Global Diversity Information Facility (GBIF)
- International Gemini Observatory
- International Ocean Drilling Project (ODP)
- The Square Kilometre Array initiative (SKA)
- Anglo Australian Telescope/Anglo-Australian Observatory (AAT)
- Isaac Newton Group Telescopes
- Joint Institute for Very Long Baseline Interferometry in Europe (JIVE)
- European Laboratory for Particle Physics (CERN)
- European Synchrotron Radiation Facility (ESRF)
- European Incoherent Scatter Scientific Association (EISCAT)
- Joint European Torus (JET)
- European Molecular Biology Laboratory (EMBL)
- International Cancer Genome Consortium (ICGC)

Even "everyday" research endeavours are becoming increasingly more complex and multilateral than before. International research largely operates outside the scrutiny of diplomacy, though it may be underpinned by existing S&T agreements, and ongoing umbrella science diplomatic activity. Many such agreements are bilateral in nature, while interoperability, to be effective, should be

[14] 'Science diplomacy' refers to the involvement of science in international diplomatic discussions. For further detail see the Royal Society policy document *New frontiers in science diplomacy*

multilateral. In our next Discussion Paper we will take interoperability as a key issue for the facilitation of everyday research, and examine the challenges to it, and how they might be met through effective policies and practical actions.

The geopolitical context

This discussion is taking taken place at a time when research and innovation policies and funding are in a particular state of flux across the globe. Affecting all national policy discussions is the fallout from the global financial crisis (GFC), which is reducing or flat-lining government funding for research and innovation in many countries, but also polarizing political discussions about funding priorities and the role of research and innovation in response to the crisis. The response so far to how national budgetary constraints should play out in the research and innovation domains varies widely across nations.

The established science powers in Europe, North America, leading Asian countries, and other developed nations such as Australia and New Zealand, stand to gain enormously from making their own systems more interoperable with each other, given their common political systems and cultures, in order to remain competitive in a world where new scientific powers are emerging (China, India, Brazil, etc.) and increasingly dominating discussions around research and innovation.

These emerging nations pose some obvious challenges with respect to innovation and industrial competitiveness, but also offer opportunities. Increased interoperability can allow the more established nations access to different scientific cultures, perspectives, and resources (human, financial, biological, etc.), as well as new collaborators, suppliers, and customers within both scientific and industrial supply chains. Rather than the "us vs. them" divisiveness that may be the first response to emerging foreign strengths, increased collaboration and support could be more easily fostered.

Further, third world nations should not be neglected, as helping them strengthen their scientific capabilities will benefit not only them, but also the world at large. This may be especially so regarding non-innovation-driven agendas (e.g., regarding cultural protection, prosperity, world citizenship), through which global inequities are reduced and (if the lessons of individual nations apply) "global health" may be increased. This can also pay dividends on the scientific side, as the established nations obtain more and better access to scientific data that are not easily available otherwise (e.g., new information on infectious diseases, new species, ecologies, and microclimates that sometimes transform our understanding of these fields) – some recent experiences such as certain African nations' responses to HIV/AIDS lessons and treatments, or the reluctance of Indonesia to provide H5N1 ('bird flu') samples, might be avoided.

Here we look briefly at the current context for the European Union, the United States, and Australia.

The European Union

The EU is committed to the idea they have long embraced of the benefits of interoperable, multilateral scientific and

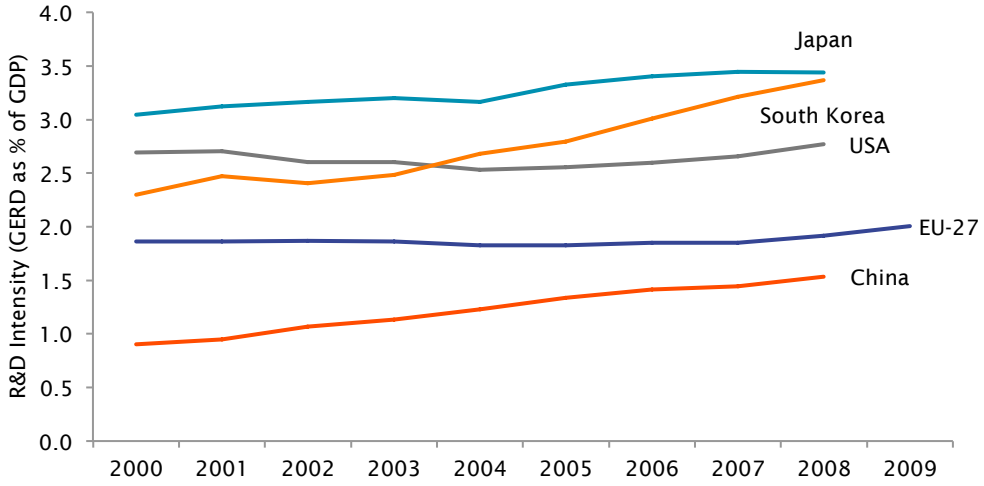

Figure 3: Evolution of R&D intensity, 2000-2009. *RIC Report 2011*, DG RTD.

technological development for the benefit of member states and the role innovation can play in creating jobs and creating economic opportunity. The core funding of the Seventh Framework Programme (FP7) and other EU wide programs remains in place, although individual member countries may be cutting funding to these areas of their national programs. The Innovation Union Flagship initiative, announced in October 2010 and endorsed in February this year begins:

> At a time of public budget constraints, major demographic changes and increasing global competition, Europe's competitiveness, our capacity to create millions of new jobs to replace those lost in the crisis and, overall, our future standard of living depends on our ability to drive innovation in products, services, business and social processes and models. This is why innovation has been placed at the heart of the Europe 2020 strategy. Innovation is also our best means of successfully tackling major societal challenges, such as climate change, energy and resource scarcity, health and ageing, which are becoming more urgent by the day.[15]

There is a recognition that whilst the EU's long emphasis on cooperation in innovation is helping it to maintain and even improve its global standing in research and innovation, the EU's R&D investment is lagging behind their main competitors Japan, South Korea and the USA, with China quickly catching up, as can been seen in Figure 3.

United States of America

Historically, the United States has a history of leadership in encouraging and participating in international S&T collaborations. Often, the US has appeared to trade the opportunity for other nations to collaborate with it in S&T, and thus to receive a boost in local development, in return for progress in accomplishing US foreign policy goals in non-scientific arenas. As other nations have emerged as leaders in S&T, the US has struggled at times to reframe its support of international R&D collaboration from an assistance model to a national S&T interests model.

At present furthermore, the United States is experiencing deep division on the question of international cooperation in R&D, as on many other issues. The current President is committed to finding international solutions to global problems, but is constrained by the emergence of overlapping isolationist and libertarian political forces, powerful in Congress, emphasizing small government and budget reduction. The "Tea Party" and related political forces tend not to embrace immigrants; are protective of national sovereignty and distrustful of international organizations; are libertarian in that they advocate minimising the role of government and public expenditure; and are sceptical of expertise, especially scientific, technical and economic expertise. Consequently, these political forces are unlikely to accept experts' claims of the nature of problems and the need to act; are likely to reject international approaches to resolving problems, especially if those approaches involve some compromise of national sovereignty and/or establishment of international entities; and are unlikely to support public expenditure to address problems they are not concerned about, especially if it involves supporting other countries.

The emergence of high-tech competitors to the US (particularly China, India, and South Korea) is also affecting perceptions of the value of spending government funds on science and technology, or of cooperating internationally in research and development. US companies have been outsourcing jobs to these emerging economies, aided by various free trade agreements, so innovation developed in the US can be perceived as having led to job losses, not economic advantage.

On the other hand, policymakers are convinced that the US standard of living depends on maintaining its lead in science and technology, and that the US needs to cooperate more to learn from competitor countries and to replace funds cut from domestic budgets. However, the language used in the recently enacted appropriation bill for Fiscal Year 2011 for NASA, that prohibits using any federal funds provided to NASA to support S&T collaboration with China, suggests that this view is far from universal amongst policymakers.[16]

Australia

In Australia's case the federal budget, due in early May this year, is rumoured to contain significant funding cuts to the biomedical science research budget, and the future of the International Science Linkages program (currently winding down) remains uncertain. Despite being relatively cushioned from the GFC by the continuing

[15] *Europe 2020 Flagship Initiative: Innovation Union*

[16] U.S. Spending Bill Limits Joint Efforts With China, *Science*, April 2011

strong demand from China, particularly for its resources, recent disastrous floods and cyclones have created a large, though temporary, setback for government revenues, and in addition it has committed to returning the budget to surplus, following its stimulus measures of 2008, by 2013. In this environment the kind of case being made by the European Commission quoted above for a concentration of resources on innovation within a long term strategic vision is difficult to make heard.

What's next?

Within this challenging environment, including the increasing costs of research and research infrastructure, and the decreasing national revenues of many developed countries, it is timely for nations to examine their strategies for international engagement in research, and to work with international agencies (such as the United Nations and the OECD) and scientific bodies (such as the many scientific unions)[17] to enhance the process of conducting international research. This will lead to an increase in the amount and quality of research being conducted whilst at the same time decrease transaction costs and duplication of work. Further, problems that can only be addressed on a global scale are becoming increasingly important and apparent, providing additional impetus to such collaborations.

A full discussion of the major challenges to becoming more interoperable, as well as possible solutions to these problems, will be detailed in FEAST's next Discussion Paper.[18]

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